



503.39364X00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: NAKAMURA et al
Serial No.: 09/727,535
Filed: December 4, 2000
For: High Strength Mg Based Alloy And Mg Based Casting Alloy And Article Made Of The Alloy
Art Unit: 1742
Examiner: Sikyin Ip

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JUL 11 2003
GROUP 1700

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REQUEST FOR RECONSIDERATION

Mail Stop: Amendment
Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

July 9, 2003

Sir:

This is in response to the Office Action mailed April 9, 2003, in connection with the above-identified application.

Claims 1, 2, 4 - 11, 22 - 23, 26, 27, 31 and 33 stand "rejected under 35 USC 103 as being unpatentable over DE 1259578 (abstract) in view of acknowledged prior art admission from page 1, line 11 to page 3, line 15 of the instant specification."

Applicants traverse this rejection and request reconsideration thereof.

The invention as presently claimed herein is directed to novel Mg casting alloys, which are injection molded using a metal mold, and which can be effectively utilized for various products.

Various casting Mg alloys, such as AZ91D, have been utilized. However, with

the growing need for relatively thin products, and high precision of, e.g., cast parts, to reduce weight and size of portable devices, high fluidity alloys have been required. The fluidity may be improved by raising the temperature of the molten alloy; however, raising the molten alloy temperature has problems in oxidation of the molten alloy and in shortening the durable lifetime of machines used in producing parts made of the alloy. Therefore, it is necessary to improve fluidity by other methods. See the last full paragraph on page 2 of applicants' specification.

According to the present invention, as detailed in the specification, specifically adding Sn into a conventional Mg-based alloy of AZ91D group in an amount of 0.5% or more lowers the melting point of the alloy about 16°C down to about 550°C as shown in Fig. 3 of the present application. As shown in Fig. 4, the alloy of the present invention exhibits improved fluidity for eased application of the Mg alloy to die-casting and injection molding for various metal products. Further, according to the present invention, adding Sn in an amount of 0.5% or more into alloy No. 11 (which corresponds to a conventional Mg-based alloy of AZ91D group) notably increases the hardness and tensile strength of the alloy. This feature is shown in Figs. 5 and 6. As shown in Fig. 7, however, the addition is limited to 10% or less because excessive addition of Sn in an amount of more than 10% largely lowers the elongation rate thereof down to 2% or less. Thus, addition of at least 0.5% and up to about 10% still give a notable effect of a large improvement in the strength and elongation performance.

More specifically, the Mg-based alloy of the present invention exhibits higher molten fluidity length than AZ91D at equivalent temperatures and, moreover, exhibits equivalent fluidity length as AZ91D at lower temperatures than AZ91D. As shown in

Figure 4 of the subject application, at the forming temperature of 600°C, the average flow length of the Mg-based alloy of the present invention is about 350 mm while that of AZ91D is 290 mm. Thus, the present invention exhibits better fluidity length than AZ91D at equivalent temperature. Thus, use of the Mg-based alloy of the present invention permits objects that were difficult to be formed using AZ91D to be more easily formed. Moreover, use of the present alloy makes it possible to form more complicated and thinner products than those products which have been conventionally produced with existing Mg-based alloys. Thus, yield can be improved. Moreover, use of the alloy of the present invention makes it possible to cast a product in one piece where it may have had to have been fabricated in the prior art using a plurality of parts. This leads to not only a reduction in the number of processes in the manufacture of the product, but also to reductions in costs.

As also shown in Figure 4, the average flow length of AZ91D at 600°C is about 290 mm. The alloy of the present invention (Mg₁₂Al₁Zn₅Sn) can achieve the same flow length of 290 mm at about 575°C. Thus, products that until now have been formed at 600°C using AZ91D can be formed at 575°C if the alloy of the present invention is used. Forming at a temperature below 580°C is difficult using AZ91D because the flow length thereof is as short as 50 to 150 mm as shown in Figure 4. By forming at lower temperatures, it is expected that the durability of the molds and cylinders can be increased, thereby improving productivity and cutting costs.

As also shown in Figure 4, the flow lengths of the existing alloy AZ91D show no significant improvement with increase in temperature over 600°C and show a large variation at the saturation temperature of over 205 to 305 mm, resulting in low yield.

While the alloys of the present invention also do not show significant improvement over a certain temperature (lower than that of AZ91D), the variation of flow length at the saturation temperature is as small as 50 mm, thus increasing the yield as compared with AZ91D.

As can be seen from the data in the subject application, especially Figure 4, the Mg alloys of the present invention exhibit unexpectedly advantageous results as compared to existing alloys such as AZ91D.

The DE 1259578 abstract discloses Mg alloys containing metal additions, e.g., Mg_9Ba , Mg_2Co , Mg_2Ge , Mg_3Sb_2 , Mg_2Si or Mg_9Sr , which are soluble in a melt but soluble only up to 0.1% below the solidus temperature. The Abstract indicates that mechanical strength of the Mg alloys may be further improved by additions of Mn .1 to req. 2.5, Al .1 to req. 13, Zn .1 to req. 9, Ag .1 to req. 16, Bi .1 to req. 11, Ca .1 to req. 1, Li .1 to req. 15, Sn .1 to req. 16, Zr .1 to req. 1, Th .1 to req. 8, rare earth metals .1 to req. 2%.

While DE 1259578 discloses a broad range for the Al content of 1 to 13% and for the Sn content of 0.1 to 16%, there is no suggestion that the Al content should be at least 12% in combination with the Sn content being 0.5 to 10%. In fact, most of the described range of Al content in DE 1259578 is outside the presently claimed range. There is no suggestion in the DE 1259578 abstract that using a Al content of at least 12% increases the tensile strength to about 280 MPa or more and that the high Al content should be done in combination with the Sn content of 0.5 to 10% to improve the elongation. See Figures 4, 7 and 8 of applicants' specification.

Moreover, DE 1259578 relates to powder metallurgical manufacture of magnesium alloys. There is no disclosure in the DE1259578 abstract suggesting that

the alloy should be used as a casting alloy which is injected molded. As noted above, with reference to, e.g., Figure 4 of the subject application, one aspect of the present invention is that the addition of a specific amount of Sn to an existing AZ91D alloy lowers the melting point of the alloy and improves the molten fluidity length so as to provide unexpectedly advantageous results in terms of using the alloy for injection molding. Because there is no suggestion of the use of the alloy described in the DE 1259578 abstract for injection molding, it is submitted there would have been no motivation to modify the alloy described therein to arrive at the presently claimed invention. In particular, there is no suggestion in DE 1259578 of choosing the Al and Sn contents in the ranges presently claimed. While the Examiner alleges that a prima facie case of obviousness exists where the claimed ranges in the prior art do not overlap but are close enough that one skilled in the art would have expected them to have the same properties, it is noted that applicants have demonstrated the addition of a particular amount of Sn provides unexpectedly advantageous results in terms of melting point and fluidity length. Such is neither disclosed nor suggested by DE 1259578. Accordingly, the presently claimed invention is patentable over DE 1259578.

Claims 1, 3 - 11, 22 - 23, 26, 27 and 31 - 33 stand rejected under 35 USC 103 as being unpatentable over United States Patent No. 5,964,965 to Schulz et al "in view of acknowledged prior art admission from page 1 line 11 to page 3, line 15 of the instant specification." Applicants traverse this rejection and request reconsideration thereof.

The Schulz, et al patent discloses a lightweight Mg based material or Be based material having the ability to reversibly store hydrogen with very good kinetics. The material is of the formula $(M_{1-x}A_x)D_y$, as defined in column 4, lines 20-36 of this patent.

This patent further discloses that the material is in the form of a powder of particles. See column 4, line 37.

Clearly, this reference neither discloses nor would have suggested, and in fact would have taught away from, the alloy which is injection molded in a metal mold, as in the present claims, or amounts of the various components as in the present claims which provide the accomplishment that the alloy can be injection molded in a metal mold. It is emphasized that Schulz discloses material in the form of a powder of particles, which would have taught away from the alloy as presently claimed. Nothing in the prior art described in applicants' specification would have suggested modifying the Schulz et al patent to arrive at the presently claimed invention.

Moreover, to arrive at the presently claimed invention from the disclosure of Schulz et al, one of ordinary skill in the art would have to selectively pick and choose the appropriate elements represented by the symbols M, A and D in the appropriate amounts. Neither the Schulz et al patent nor the knowledge generally available to one of ordinary skill in the art would have provided any basis for selectively picking and choosing the elements and amounts to arrive at the presently claimed invention. Moreover, it is submitted the presently claimed invention provides unexpectedly advantageous results based on the elements making up the alloy and the claimed ranges. Such is neither disclosed nor suggested by Schulz et al.

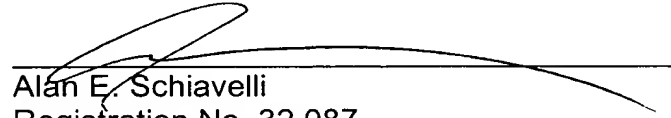
Applicants note the indication of allowable subject matter in claims 28 - 30 and 34 - 39. However, in view of the foregoing remarks, it is submitted all of the claims now in the application are in condition for allowance.

To the extent necessary, applicants petition for an extension of time under 37

CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 503.39364X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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